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DYNAMIC MODULUS TEST FOR ASPHALTIC CONCRETE

COMPUTER PROGRAM DOCUMENTATION and USER'S GUIDE

MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE

DYNAMIC MODULUS TEST FOR ASPHALTIC CONCRETE
COMPUTER PROGRAM

Part 1: DOCUMENTATION
Part 2: USER'S GUIDE

by

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TECHNICAL REPORT DOCUMENTATION PAGE

DYNAMIC MODULUS TEST for ASPHALTIC CONCRETE
COMPUTER PROGRAM DOCUMENTATION

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Abstract:

A computer application program has been developed for testing the *dynamic modulus* of bituminous mixtures in the laboratory, using the MTS BASIC language. The program was written for the specific environment of the Materials Testing System (MTS Model 442-11) which includes a 468 Test Processor, a Digital PDP-11/23 plus microcomputer and other equipment. The test is based on the ASTM D3497 standard method.

After initial test setup, the user enters information required by the program and starts the test. Subsequently, the program controls the load generation, performs data acquisition, processes the acquired data, calculates test results, presents the results in tabular format, and saves the results to a disk file.

The first part of this report documents the most essential design elements of the program. Appendices contain the listing of the application and other information which enables programmers to make changes to the program if necessary.

The second part of the report is a "User's Guide". It provides information required by a technician to operate the program and complete a dynamic modulus test.

Abrégé:

On a mis au point un programme d'application sur ordinateur permettant de mettre à l'essai, en laboratoire, le *module dynamique* des mélanges bitumineux à l'aide du langage MTS BASIC. Ce programme a été conçu spécialement pour le système d'essai des matériaux (modèle MTS 442-11), qui comprend un processeur d'essai 468, un micro-ordinateur Digital PDP-11/23 plus et d'autres composantes. L'essai est basé sur la méthode de normalisation ASTM D3497.

Après la préparation initiale de l'essai, l'utilisateur entre les données dont le programme a besoin et amorce l'essai. Le programme contrôle ensuite l'application de la charge, saisie et traite les données, calcule les résultats de l'essai et les présente sous forme de tableau, et sauvegarde le tout sur disquette.

La première partie du rapport décrit les principaux éléments de conception du programme. On trouvera dans les annexes la liste d'application et d'autres renseignements permettant aux programmeurs de modifier le programme, le cas échéant.

La seconde partie du rapport est un guide d'utilisation qui permettra aux techniciens de faire fonctionner le programme et d'effectuer l'essai de module dynamique.

Keywords: Computer program, dynamic modulus, asphalt mixes, servo-hydraulic automated laboratory testing, data acquisition, program documentation, user's guide.

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CONTENTS

PART 1. PROGRAM DOCUMENTATION

1. INTRODUCTION 1

2. TEST OUTLINE 1

3. PROGRAM PRE-REQUISITES AND LIMITATIONS 2
   3.1. MINIMUM HARDWARE AND INSTRUMENTATION REQUIREMENTS 2
   3.2. TEST SPECIMEN 2
   3.3. TEST ASSUMPTIONS 2
   3.4. LIMITATIONS 3
   3.5. SUPPLEMENTAL INFORMATION 3

4. LOADING GENERATION MODEL 3

5. IN-LINE DATA ACQUISITION AND PROCESSING 4

6. CALCULATIONS 4

7. HARD DISK STORAGE 5

8. INTERPRETATION OF PROGRAM OUTPUT 6

9. COMMON PROBLEMS AND TROUBLESHOOTING 6

PART 2. USER 'S GUIDE

1. DESCRIPTION OF TEST MENU ITEMS 9

2. INSTRUCTIONS FOR THE USER'S INPUT 10
   2.1. GENERAL 10
   2.2. SAMPLE AND TEST IDENTIFICATION 10
   2.3. TEST SPECIFICATIONS 10

3. USER'S CONTROL OVER THE TESTING PROCESS 12

4. PROGRAM OUTPUT 13
   4.1. SCREEN OUTPUT DURING TESTING 13
   4.2. TESTING RESULTS 13

5. USER'S INPUT AND PROGRAM OUTPUT 14

APPENDICES TO PART 1:

A - DESCRIPTION OF VARIABLES USED IN THE PROGRAM
B - DYNAMIC MODULUS TEST LOADING PATTERN
C - THE PROGRAM CODE LISTING

APPENDIX TO PART 2:

D - EXAMPLE OF PROGRAM INPUT AND OUTPUT

PART 1

PROGRAM DOCUMENTATION

1. INTRODUCTION

This report provides a brief outline of the dynamic modulus test and details the computer software program for the test in two parts, *Part 1 - Program Documentation* and *Part 2 - User's Guide*.

The program documented in this report is written, using the MTS BASIC high-level interpreted language of the 773MU Series, for the testing system set up in use in the Ministry Bituminous Evaluation Laboratory. The system consists of the MTS testware and the Digital MicroPDP-11 computer. The computer program controls the dynamic modulus test execution and performs all other functions (data acquisition, calculations, presentation of results, etc.) as required by the user.

The dynamic modulus test is relatively easy to perform and it is one of the many tests used for determining the viscoelastic response of bituminous materials to dynamic loading. As such, dynamic modulus is used for both asphalt mixture evaluation and pavement thickness design. It is possible, along with the Poisson's ratio, to describe the material response to any given loading pattern by means of transformation technique (as mentioned in many related publications, e.g. Special Report 126 "*Structural Design of Asphalt Concrete Pavement Systems*", Highway Research Board, 1970).

The program was first used in early 1988. So far, tests carried out using this program were only at room temperature. However, experience has shown that particular attention has to be given to both the loading fixture and the vertical strain measuring instrumentation to get correct and reproducible results.

2. TEST OUTLINE

The program is developed for the test procedure as standardized in the ASTM standard D3497: Dynamic Modulus of Asphalt Mixtures. The following briefly outlines the test:

A cylindrical specimen with a minimum diameter of 101.6 mm and height-to-diameter ratio of 2:1 is placed vertically in a loading fixture. If the specified temperature is not at room temperature, the specimen is tested inside an environmental chamber set at the required temperature. The instrumentation required for measuring the vertical strain is connected to the testing system. Prior to testing, the specimen is properly seated and subjected to a haversine axial compression stress at three different loading frequencies, as specified.

The program uses channel 2 of the Micro Segment Generator to generate appropriate loading pattern. The specimen response (strain) is monitored using channel 5. The

acquired data can be presented in tabular format for analysis if necessary. The recoverable axial strain of the specimen is used to calculate the dynamic modulus.

The test is performed for three different temperatures (5, 25, and 40°C), using the same specimen and starting at the lowest temperature.

Test results and the corresponding test frequencies are reported.

3. PROGRAM PREREQUISITES AND LIMITATIONS

3.1. MINIMUM HARDWARE AND INSTRUMENTATION REQUIREMENTS

System components such as a microcomputer PDP-11/23-PLUS or LSI-11/23, mass storage device (min. 10 MB), system controlling terminal VT240 and MTS 468.10 test processor including a Micro Segment Generator are involved.

The testing apparatus used in the procedure must be uniform and level to ensure even distribution of applied load over the test specimen cross-sectional area. The endplates should be in direct contact with the MTS loading arrangement.

The test requires properly calibrated instrument (e.g. extensometer, LVDT) for accurate measurements of vertical strain. All instruments attached to the specimen must be fixed firmly during the dynamic loading.

For better accuracy of test results, the peak load to be used should be at least 10% of the load cell capability. The range of LVDTs or extensometers employed should cover the anticipated specimen deformation (i.e. within the controllable range and the 10% load cell range).

3.2. TEST SPECIMEN

The end surfaces of a test specimen must be parallel and perpendicular to the vertical axis. Capping may be necessary in some cases to meet this requirement.

The specimen should be examined visually for any signs of damage, irregularities, cracks etc.. Only uniform specimens should be used for the test.

3.3. TEST ASSUMPTIONS

In order for the program to function properly and to produce consistent results, the following assumptions are made:

- the specimen is structurally sound, coherent, uniform in composition, and regular in shape;
- the specimen is properly seated after load conditioning in a test jig;

- ➤ the test temperature is kept constant for the duration of the test and uniform within the specimen;
- ➤ the specimen is uniformly loaded over the endplates and the load is applied uniaxially;
- ➤ the total vertical deformation of a specimen is kept below a specified limit to ensure no permanent structural damage is incurred at any stage of the test, i.e. nearly all of the specimen deformation are recoverable;
- ➤ the end-effect is considered negligible for the purpose of calculating the vertical strain measured between the two pairs of points vertically along the specimen surface.

3.4. LIMITATIONS

The limitations are mainly from the test controlling hardware (e.g. range cartridges, controlled temperature cabinet, extensometers) rather than the software itself. Specifically, the following loading frequency limits are applicable:

- minimum .00025 Hz,

- maximum 920 Hz.

The only possible software limitation is the maximum number of loading cycles of 2,000. This means that the testing time for each of the three frequencies is restricted to approximately 95 s. However, in the case of standard dynamic modulus testing, this time limitation is not a problem.

3.5. SUPPLEMENTAL INFORMATION

The execution time for a single standard test is below three minutes, not including the time needed for test setup and specimen conditioning prior to testing. It is recommended that several hundred cycles of 1-Hz haversine load be applied for the preconditioning load to sufficiently stabilize the deformation measurements at 100 to 300 kPa, depending on test temperatures.

If a test is carried without using the temperature controlling cabinet, the loading should be completed within two minutes of removing the specimen from a controlled environment. This could be hard to achieve and therefore not recommended.

The program is developed primarily for testing asphalt mixes. However, it could also be used for testing other viscoelastic materials when suitable test loading pattern is selected.

4. LOADING GENERATION MODEL

A compressive pulsating load of a haversine pattern is exerted on a test specimen using a multiple frequency **FGRAMP** function that generates three blocks of segments at

specified frequencies, under LOAD control. The loading sequence is illustrated in Appendix B.

5. IN-LINE DATA ACQUISITION AND PROCESSING

Two data acquisition processes are activated at the start of dynamic loading of a specimen, as shown in the table below.

PROCESS NO.	PROCESS ID.	ACTION PERFORMED	MASTER CHANNEL
1	ADPKVAL	Detects and stores in an array VA2(.) signal amplitude peaks and valleys at the specified channel. The signal reversal level (= noise band) is set in the variable M1.	2
2	ADPKVAL	Detects and stores in an array VA3(.) signal amplitude peaks and valleys at the specified channel. The signal reversal level (= noise band) is set in the variable M2.	5

6. CALCULATIONS

The following computations are performed using the data acquired during the test. The meaning of symbols used here is explained under description of variables. All strain values are given in microstrains.

- All binary values of peaks and valleys stored in data arrays VA2 and VA3 are converted into engineering volts (arrays W(i) and D(i)).
- Average amplitude values for the axial load (W1, W2, W3) and recoverable strain (E1, E2, E3) measured during the last three loading cycles at each loading frequency.
- The value of axial stress at each loading frequency:

$$S_i = \frac{W_i \times UI}{10^6 \times 3.14159 \times \frac{Z^2}{4}}$$

- The value of dynamic modulus at each loading frequency:

$$E_i = 10^6 \times \frac{S_i}{E_i}$$

- Average values of axial stress, recoverable strain, and dynamic modulus:

$$S0 = \frac{(S1 + S2 + S3)}{3}; \qquad E0 = \frac{(E1 + E2 + E3)}{3}; \qquad E = 10^6 \times \frac{S0}{E0}$$

7. HARD DISK STORAGE

As soon as a test is completed results are saved on hard disk. A hard copy of all the test results can also be obtained. This is done by selecting the 'SAVE TEST RESULTS' item from the test menu. The name of the file is assigned automatically with an appropriate message confirming the name. A message 'TEST RESULTS ARE SAVED ALREADY!' will be displayed if the results have been saved earlier. This prevents duplication of saving the same test results.

Saved data can be transferred to a database, or recalled for viewing/printing (using the RT-11 system utility) when needed later.

Normally, the data items listed below are saved for each single dynamic modulus test.

1__J$(5)	Test identification code.
2__T5	Consecutive number of the dynamic modulus test results to be saved.
3__D$	The system date returned by DAT$ function (DD-MM-YY).
4__J$(2)	Specimen identification code.
5__J$(3)	Date of the sample (sampling or preparation).
6__J$(4)	Mix design identification code.
7__J$(6)	Test specimen height, mm.
8__J$(7)	Test specimen diameter, mm.
9__J$(1)	Pavement sample identification code.
10__J$(8)	Test specimen mass, kg.
11__J$(9)	Distance from pavement edge/curb, m.
12__L$(8)	Load calibration factor, N/V.
13__???	0.0 (Reserved).

14__L$(9)	Strain calibration factor, mm/V.
15__???	0.0 (Reserved).
16__L$(6)	Test temperature, °C.
17__L$(11)	Test humidity, %.
18__L$(1)	Peak load applied in the test, V.
19__L$(2),L$(3),L$(4)	Loading frequencies, from the highest to the lowest.
20__3*L$(5)	Test loading duration, s.
21__L$(10)	Spacing between the LVDT's clamps, mm.
22__E4	Dynamic modulus at the highest loading frequency, MPa.
23__E5	Dynamic modulus at intermediate loading frequency, MPa.
24__E6	Dynamic modulus at the lowest loading frequency, MPa.
25__M4$	NOTES entered by the user in the Test Report (four strings).

The end of file is marked with '{{0)} ' string.

8. INTERPRETATION OF PROGRAM OUTPUT

With better control of test setup and testing conditions, higher accuracy of test results can be obtained. If the listed values of peaks and valleys from a test increase uniformly, it is likely that the test has been carried out properly and the results are correct.

It is recommended that a hard copy of the results be obtained immediately after a test for review while all details of the test are fresh in the operator's mind, and still being kept in the computer memory for retrieval when necessary.

The results of a single dynamic modulus test must always be interpreted with care because of the use of a single test result could be misleading. Proper evaluation of the results can only be made from multiple results of the same mix type and test conditions.

9. COMMON PROBLEMS AND TROUBLESHOOTING

The dynamic modulus test is a relatively easy test to perform, when proper instrumentation and test apparatus are used. It can be repeated many times within a short period of time.

The only problems encountered to date are those related to test setup and peak load value used in the test, leading to cluttered strain and amplitude values and finally incorrect dynamic modulus values. More difficulties could be expected when test is carried out at elevated temperatures such as higher than 30°C.

There are several reasons for these to happen:

- test load might not have been transferred uniformly and/or perpendicularly to the end surfaces of a test specimen,
- test load could be too low to produce a sufficient vertical deformation,
- test load could be too high, producing excessive plastic deformation.

A close look at the test setup, acquired data, and test specifications is necessary to determine the cause of the problems.

PART 2

USER'S GUIDE

1. DESCRIPTION OF TEST MENU ITEMS

For proper testing, the following items have to be accessed sequentially, starting from menu item No. 1:

① **IDENTIFY SAMPLE**

Accepts data entry for sample identification and description.

② **DETERMINE TEST SPECS**

Accepts data entry for test specifications.

③ **RUN THE TEST**

Invokes the program to engage the MTS servo-hydraulic hardware and starts testing, including load function generation and data acquisition.

④ **PLOT DATA GRAPH**

This item is reserved for future use.

⑤ **DISPLAY DATA**

Presents submenu with the following options:

<1> LIST ALL

<2> SELECTED ONLY

<3> SUMMARY ONLY

<4> EXIT

So far, options 1 to 3 remain the same and present identical tables of load-strain data points (peaks and valleys).

⑥ **PRINT TEST REPORT**

Prints the summary of test results as displayed on the screen.

⑦ **SAVE TEST RESULTS**

Saves essential test results to a disk file.

⑧ **QUIT THE PROGRAM**

Exits the program. Testing information remains accessible so long as no new program is loaded or the system is not shut down.

2. INSTRUCTIONS FOR THE USER'S INPUT

2.1. GENERAL

- To quit data entry at any time, type ? + ↵. The program will return to the menu screen.
- To correct any single data item - follow on-screen instructions given after completing the data entry.
- To change the whole set of data entry or part thereof - recall the relevant data entry screen and enter correct data.
- To clear all data variables in computer memory - exit the program and load it anew.

There are two steps in the data input of the program:

- ❒ sample identification and description,
- ❒ test specifications.

2.2. SAMPLE AND TEST IDENTIFICATION

Entries 1 through 5 are predetermined by formats as defined in the database application, and should be followed strictly to ensure compatibility with the database. The meaning of symbols in data entries, shown in the Appendix D, is given in the Evaluation Laboratory database documentation.

The next three items (6 to 8) characterize the size and mass of the test specimen. They must be entered according to the specified units and results of measurements. The last item (9) records the location of sample material within the pavement width in relation to the right-hand edge (shoulder) of the pavement. This is not applicable to specimens which are not from a pavement. In such a case, enter **0.00** for item No. 9.

2.3. TEST SPECIFICATIONS

Loading frequencies (#1, #2, #3), Hz

Enter three consecutive testing frequencies as planned. Normally, entries of 16, 4 and 1 are specified. If, for some reason, different frequencies are required, enter them carefully in decreasing order, i.e. from the highest to the lowest. The acceptable range is from .00024 to 920 Hz.

Time of loading at each frequency, s

Enter the duration of loading the specimen at each specified frequency. If you enter a value of, say, 30 s, the total loading time in the test will amount to $3 \times 30 = 90$ s. Keep in mind that there is a maximum limit of 2,000 for the total number of loading cycles within a test; so, before you enter a loading time, ensure that the value resulting from the following expression is not to exceed 2,000.

$$\text{TIME} \times (\text{FREQ1} + \text{FREQ2} + \text{FREQ3})$$

Load to be applied, Volts

Enter peak load value in volts. For example, for a 3.25 volt and with a range load cartridge of calibration factor equal to 222.4 N/V, the equivalent load value would amount to about 723 N. The value entered must be positive and less than 10.

CAUTION!

- Double check your value. This entry is crucial for validity of test results and machine operation safety.
- There is no self checking mechanism in the program for this entry. Wrong value can cause damage to the machine, instrumentation and specimen.

Test temperature, °C

Enter temperature to be kept constant during the test.

Load waveform (S, R, SQ)

Enter one of the three options given in parentheses. Normally, a sinusoidal waveform ('S') is used in standard testing. If other waveforms are used, enter 'R' for RAMP waveform and 'SQ' for SQUARE waveform.

Load calibration factor, N/Volt

Enter the appropriate calibration value of the MTS load cartridge in use.

Strain calibration factor, mm/Volt

Enter the calibration factor for the type of LVDTs or other instruments used in the test.

Spacing between LVDT clamps, mm

Enter the effective specimen height for determining the vertical strain.

Test humidity, %

Enter the relative air humidity at the time of testing.

3. USER'S CONTROL OF TESTING PROCESS

Once all required input data are entered, and all the hardware and specimen are properly set up, the test is ready to start automatically.

Select item ③ from the test menu. The following messages will be on display:

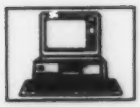
```
PLEASE VERIFY THE CONTROLLER'S SETTINGS AND MODE OF CONTROL,
AND ZERO TRANSDUCERS.

ESC'S MAY BE USED TO STOP THE TEST AT ANY TIME.

ENTER 'GO' TO BEGIN THE TEST:
```

When all is ready, start the test by following the on-screen instructions.

Since all test controls are now run automatically, and if at some point there is a need for stopping the test, then touch the ESC key and 'S' key:

ESC & S

In response, the program will immediately abort the load waveform generation and return to the test menu screen. New testing with modified information or correct test setup can now be repeated.



The following signals the end of a test:

```
TEST COMPLETED

COMPUTING. PLEASE WAIT...
```

During the test, there is an option of either using the MTS Data Display Unit, the Oscilloscope, or/and the Recorder/Plotter to monitor the actual readings on any active channel(s) of particular interest.

4. PROGRAM OUTPUT

4.1. SCREEN OUTPUT DURING TESTING

The following message is displayed:

```
DYNAMIC MODULUS TEST IN PROGRESS...
```

4.2. TESTING RESULTS

On selection of "DISPLAY DATA" item from the test menu, a submenu is presented:

<1> LIST ALL

<2> SELECTED ONLY

<3> SUMMARY ONLY

<4> EXIT

Choose one of the first three options to get formatted table display of load-strain data points listed under the following columns:

- time elapsed (s) since the start of dynamic loading, at which a current loading cycle is generated,
- load peaks and valleys (volts),
- strain peaks and valleys (volts).

Three example segments of the table are presented in Appendix D.

"TEST REPORT" screen is displayed upon selection of "PRINT TEST REPORT" item from the test menu. The format of a standard report is illustrated in Appendix D. It contains sample identification data, test specifications and the test results, i.e. the values of dynamic modulus calculated for the three specified testing frequencies (the highest, intermediate, and the lowest). There is also room at the bottom of the screen for short but important comments related to the test. This information is normally saved to a disk file with all other test data.

5. USER'S INPUT AND PROGRAM OUTPUT

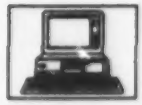
Dynamic modulus test results tend to be quite consistent from test to test for a given mix, test temperature and loading frequency. An example is given in Appendix D to illustrate the user input and the program output.

DESCRIPTION OF VARIABLES USED IN THE PROGRAM

(A) NUMERIC VARIABLES (SCALARS)

NAME	DESCRIPTION
A	Variable used by privileged function call SYS for disabling the CTRL-C as the means of exiting a running program
A1	Specimen cross-sectional area, mm^2
B	Variable returning a value which indicates current status of hardware configuration (1 = error)
B1	User's response indicating a choice from the test menu
C	Variable, returning a current clock setting
D1,D2,D3	Strain amplitude (difference between VALLEY and PEAK) averaged for three consecutive loading cycles at the end of each of the loading frequencies (the highest, intermediate, the lowest - respectively), in Volts
D9,M9,Y9	Date (day, month, year) strings as returned by GDATE function; also, respective numeric values of the strings
E	Dynamic modulus, calculated as an average value of all three loading frequencies, MPa
E0	Recoverable axial strain, calculated as an average value of all three loading frequencies, microstrains
E1,E2,E3	Recoverable axial strain averaged for three consecutive loading cycles at the end of each of the loading frequencies (the highest, intermediate, the lowest - respectively), microstrains
E4,E5,E6	Dynamic modulus, calculated for each of the three loading frequencies (the highest, intermediate, the lowest - respectively), MPa
E7,E8,E9	Second, minute, hour, in time returned by the GTIME function
F1,F2,F3	Loading frequencies specified in the test (highest, intermediate, and lowest respectively), Hz
G	Calculated test load, N
H	Spacing between clamps supporting LVDTs, mm
I1,I2	Number of data entry items in 'SAMPLE IDENTIFICATION' and 'TEST SPECIFICATIONS' screens, respectively
J1	Flag indicating which one of two data entry screens is currently edited by a user
K1 ÷ K9	Assigned expression values for coded description of the day of a week

L1	First end level (usually zero) used in FGREPT block array function, n.e.u.
L2	Second end level used in FGREPT block array function, n.e.u.
M1	Variable specifying a reversal level (noise band) at LOAD channel; determines if a value is to be considered a peak or valley when detected by the ADPKVAL function
M2	Variable specifying a reversal level (noise band) at STRAIN channel; determines if a value is to be considered a peak or valley when detected by the ADPKVAL function
M9	See D9
N5	Number of the test menu items
S	Variable returning the number of buffer calls queued (including the currently executing call) to the micro segment generator
S0	Axial stress, calculated as an average value of all three loading frequencies, N/m^2
S1,S2,S3	Axial stress averaged for three consecutive loading cycles at the end of each of the loading frequencies (highest, intermediate and lowest respectively), N/m^2
T	Time elapsed since the start of a test (i.e. beginning of the first loading frequency), s
T0	Time of loading at each specified frequency, s
T2,T3,T4	Starting positions of T2$, T3$, T4$ strings on the screen
T5	Consecutive number of the dynamic modulus test results to be saved
U1	Value of load calibration factor, N/V
U2	Value of strain calibration factor, mm/V
W1,W2,W3	Test load amplitude (difference VALLEY-PEAK) averaged for three consecutive loading cycles at the end of each of three loading frequencies (highest, intermediate and lowest respectively), (Volts)
X0	Flag indicating that the results of a recent test have already been saved to a disk file
X8	Error code indicating the status of file opened for output of test results
Y9	See D9
Z	Specimen diameter, mm



(B) ARRAYS

NAME	DESCRIPTION
A1(3,3)	Used in FGREPT function. Stores channel levels (n.e.u.), frequency of load cycling and segment count. Each row contains information for one waveform block of the micro segment generator. Format of the array:

Block Nº	Frequency	Segment Count in a Block	Channel Nº 2	
			Level A	Level B
1	A1(1,0)	A1(1,1)	A1(1,2)	A1(1,3)
2	A1(2,0)	A1(2,1)	A1(2,2)	A1(2,3)
3	A1(3,0)	A1(3,1)	A1(3,2)	A1(3,3)

D(2000)	Stores values of peaks and valleys (in pk,vl,pk,vl... order) converted from binary values acquired at STRAIN channel, Volts
H3(10)	Stores the consecutive numbers of relevant MTS-driven tests
W(2000)	Stores values of peaks and valleys (in pk,vl,pk,vl... order) converted from binary values acquired at LOAD channel, Volts

(C) STRINGS AND STRING ARRAYS

NAME	DESCRIPTION
D$	System date (dd-mm-yy) returned by DAT$ function
F2$	The consecutive number of the Dynamic Modulus Test results to be saved
H2$(10)	Identification strings for MTS-driven tests
I$(10)	Prompts used in sample identification data entry screen
J$0,J1$	User's data entries in 'SAMPLE IDENTIFICATION' screen
K$(12)	Prompts used in test specifications data entry screen
K2$	Day of a week
K3$(7)	Substrings of the day of a week
L$(12)	User's data entries in 'TEST SPECIFICATIONS' screen

M$(30) Test data items (results) to be saved to a disk file

M4$ User's comments, if any, added after completion of the test under NOTES in the Test Report screen

O$(N5) Test menu items

T1$ ÷ T4$ Assigned string constants

V1$ ÷ V3$ Day, month, year, in the test date representation

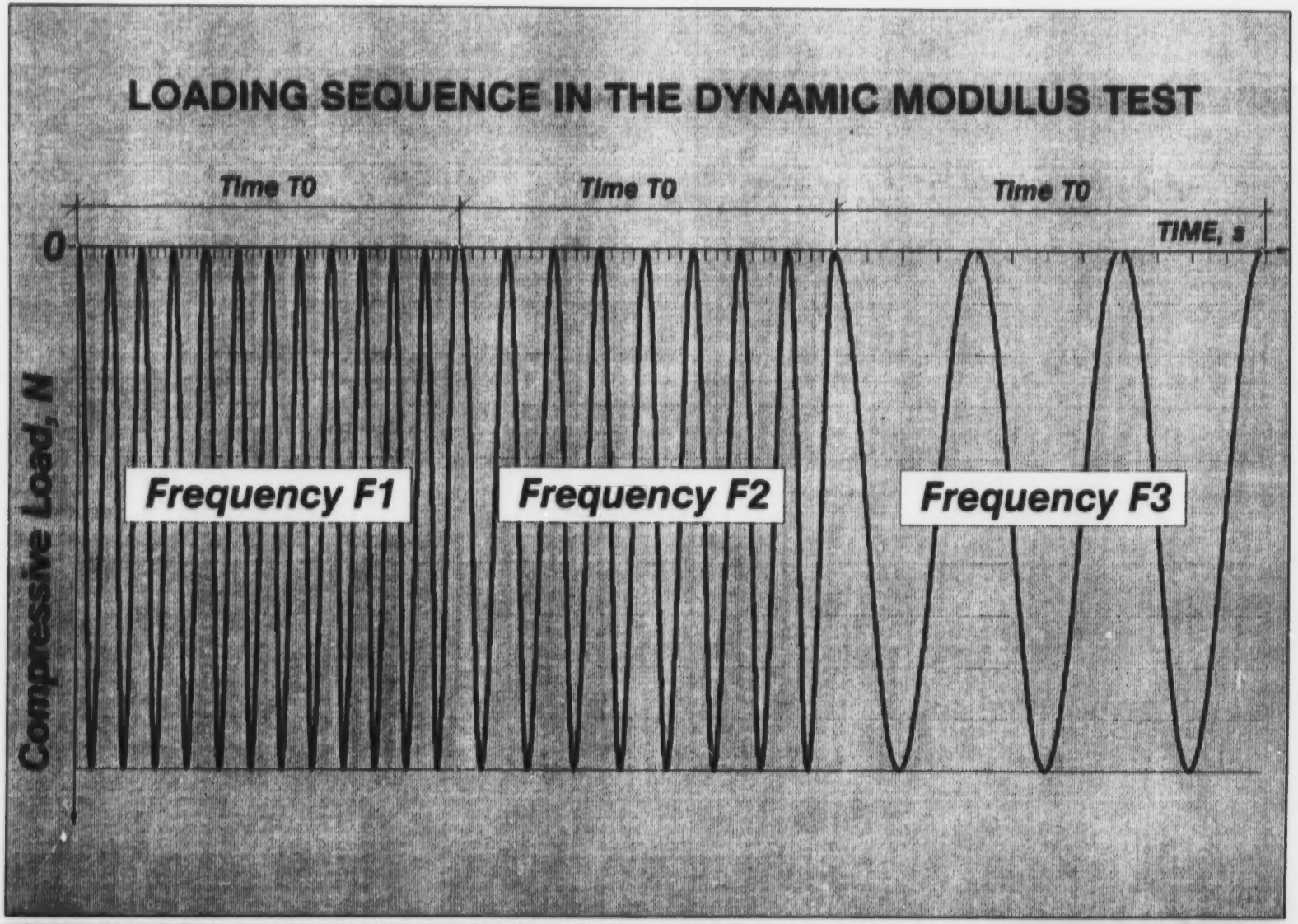
VA2(4000,1) Virtual array used in ADPKVAL function. Stores peak and valley data (in binary format) detected at LOAD channel. Format of the array:

Row N°	Number of Clock Interrupts Between Readings	Peaks and Valleys Detected at Channel N° 2	
0	[redacted]	VA2(0,1)	Initial reading
1	VA2(1,0)	VA2(1,1)	peak
2	VA2(2,0)	VA2(2,1)	valley
3	VA2(3,0)	VA2(3,1)	peak
..	.....	.....	.....
N*	VA2(N,0)	VA2(N,1)	valley

VA3(4000,1) Virtual array used in ADPKVAL function. Stores peak and valley data (in binary format) detected at STRAIN channel. Format of the array:

Row N°	Number of Clock Interrupts Between Readings	Peaks and Valleys Detected at Channel N° 5	
0	[redacted]	VA3(0,1)	Initial reading
1	VA3(1,0)	VA3(1,1)	peak
2	VA3(2,0)	VA3(2,1)	valley
3	VA3(3,0)	VA3(3,1)	peak
..	.....	.....	.....
N*	VA3(N,0)	VA3(N,1)	valley

NOTE: N* = 2×T0×(F1+F2+F3); a limit of 4,000 applies to N in the program.


LOADING SEQUENCE IN THE DYNAMIC MODULUS TEST
Time T0
Time T0
Time T0
TIME, s
0
Compressive Load, N
Frequency F1
Frequency F2
Frequency F3

THE PROGRAM CODE LISTING

```
10 REM  DYNAMIC MODULUS PROGRAM ** AUGUST 1987 ** By R. Raciborski
20 REM  ********************************* RAH.BAS ************************************
25 REM  ---------------------- Latest revision: February, 1992 ----------------------------
30 KBINT("S",1, LINE 1540 ) \ KBINT("E",1, LINE 480 ) \ KBENB \ CRT80COL \ A=SYS(8) \
    CNFWRN(B)
40 IF B=1 GO TO 60
50 FGSTOP \ ADSTOP \ GO TO 90
60 CLRTXWIN \ TXTSPOS(,12,14) \ TXTFLASH
70 PRINT "ERROR! CURRENT HARDWARE CONFIGURATION DOES NOT MATCH"
80 TXTSPOS(,13,29) \ PRINT "CONFIGURATION FILES" \ TXTNORMAL \ ETIME \ SLEEP(10) \
    CLRTXWIN \ GO TO 2000
90 DIM K3$(7),I$(10),J$(10),J1$(10),K$(12),L$(12),VA2(4000,1),VA3(4000,1),W(2000),
    D(2000),M$(30),H2$(10),H3(10)
100 I$(1)="PAVEMENT SAMPLE ID.(A999999X99):" \ I$(2)="SPECIMEN ID.(AAX99XA999):"
110 I$(3)="DATE OF SAMPLE (MMDDYY):" \ I$(4)="MIX DESIGN ID.(AA9999):"
120 I$(5)="TEST ID.(AA9999):" \ I$(6)="SPECIMEN HEIGHT (mm):"
130 I$(7)="SPECIMEN DIA.(mm):" \ I$(8)="SPECIMEN MASS (kg):"
140 I$(9)="DISTANCE FROM PAVEMENT EDGE (m):"
150 K$(1)='LOAD TO BE APPLIED (volts):
160 K$(2)='LOADING FREQUENCY #1-highest (Hz):
170 K$(3)='  "    "    #2-intermediate (Hz):
180 K$(4)='  "    "    #3-lowest (Hz):
190 K$(5)='TIME OF LOADING AT EACH FREQUENCY (s):
200 K$(6)='TEST TEMPERATURE (C):
210 K$(7)='LOAD WAVEFORM(S,R,SQ):
220 K$(8)='LOAD CALIBRATION FACTOR (N/volts):
230 K$(9)='STRAIN CALIBRATION FACTOR (mm/volts):
240 K$(10)='SPACING BETWEEN LVDT CLAMPS (mm):
250 K$(11)='TEST HUMIDITY (%):
260 T2$="*** DYNAMIC MODULUS TEST ***" \ T3$="M E N U" \ T4$="LIST ACQUIRED DATA"
270 Q0=0 \ T2=INT((80-LEN(T2$))/2) \ T3=INT((80-LEN(T3$)))/2 \ T4=INT((80-LEN(T4$)))/2
280 E0$="SELECT ITEM # FOR CHANGE"
290 M4$="" \ T1$="CORRECT ENTRY IS = " \ G=INT(VAL(L$(1))*VAL(L$(8)))
300 DATA 8,"<1>","ENTER NEW SPECS","<2>","EDIT OLD SPECS","<3>","RUN THE TEST",
    "<4>","PLOT DATA GRAPH"
310 DATA "<5>","DISPLAY DATA","<6>","PRINT TEST REPORT","<7>","SAVE TEST RESULTS",
    "<8>","QUIT THE PROGRAM"
320 I1=9 \ I2=11 \ K3$(1)="SUN" \ K3$(2)="MON" \ K3$(3)="TUES"
330 K3$(4)="WEDNES" \ K3$(6)="FRI" \ K3$(7)="SATUR" \ K3$(5)="THURS"
370 GO TO 1150
380 CLRTXWIN \ TXTSPOS(,2,24) \ TXTUNLINE \ PRINT "* TABLE OF LOAD-STRAIN DATA
    POINTS *" \ TXTNORMAL
390 TXTSPOS(,4,22) \ TXTBOLD \ PRINT "--- L O A D ---"TAB(30)"--- S T R A I N ---"
400 TXTSPOS(,5,5) \ PRINT "TIME" \ TXTNORMAL \ TXTSPOS(,5,18)
410 PRINT "-Peak-"TAB(15)"-Valley-"TAB(32)"-Peak-"TAB(47)"-Valley-"
```

```
430 PRINT  \ TXTSCROLL(,8,23) \ CURLIMON
440 FOR I=1 TO T0*(F1+F2+F3) \ IF I<=T0*F1 THEN T=I/F1
450 IF I>T0*F1 THEN T=T0+(I-T0*F1)/F2
460 IF I>T0*(F1+F2) THEN T=2*T0+(I-T0*(F1+F2))/F3
470 TXTSPOS(,I,5) \ PRINT TTAB(13)W(1+(I-1)*2)TAB(28)W(I*2)TAB(45)D(1+(I-1)*2)TAB(60)
    D(I*2) \ NEXT I
480 CURLIMOFF
490 TXTSPOS(,24,16) \ TXTINVERS \ PRINT "DO YOU WANT ANY OTHER DATA LISTING?
    (Y/N):"; \ INPUT #0:R$
500 IF R$='Y' THEN 530
510 IF R$<>'N' THEN 490
520 GO TO 1150
530 CLRTXWIN \ TXTSPOS(,3,T4) \ TXTINVERS \ PRINT T4$ \ TXTNORMAL
540 TXTSPOS(,5,31) \ PRINT "<1> LIST ALL" \ TXTSPOS(,6,31) \ PRINT "<2> SELECTED ONLY"
550 TXTSPOS(,7,31) \ PRINT "<3> SUMMARY ONLY" \ TXTSPOS(,8,31) \ PRINT "<4> EXIT"
560 TXTSPOS(,11,29) \ PRINT "YOUR CHOICE (ENTER #): "; \ INPUT #0:B1
570 ON B1 GO TO 380,380,380,1150
580 TXTSPOS(,14,25) \ PRINT "THAT'S NOT AVAILABLE, TRY AGAIN" \ GO TO 560
590 CLRTXWIN \ TXTSPOS(,2,35) \ TXTBOLD \ PRINT "TEST REPORT" \ TXTNORMAL
600 TXTSPOS(,3,7) \ PRINT "----------" \ TXTSPOS(,4,7)
610 PRINT "** DYNAMIC MODULUS TEST **" \ TXTSPOS(,4,50) \ PRINT "DATE OF TEST: "
    DAT$(D$)
620 GDATE(D9,M9,Y9) \ V1$=STR$(D9) \ V2$=STR$(M9) \ V3$=STR$(Y9)
630 TXTSPOS(,5,7) \ PRINT "----------" \ GOSUB 800
640 TXTSPOS(,5,50) \ PRINT K2$;" " "E9":"E8":"E7 \ TXTSPOS(,6,50) \ PRINT "TEST ID.:  ";J$(5)
650 TXTSPOS(,7,7) \ TXTUNLINE \ PRINT "SAMPLE IDENTIFICATION" \ TXTNORMAL
660 TXTSPOS(,8,7) \ PRINT "1.PAVEMENT SAMPLE ID.:"TAB(23)J$(1)TAB(37)"
    4.DATE OF SAMPLE:"TAB(60)J$(3)
670 TXTSPOS(,9,7) \ PRINT "2.SPECIMEN ID.:"TAB(23)J$(2)TAB(37)"5.MIX DESIGN ID.:"
    TAB(60)J$(4)
680 TXTSPOS(,10,7) \ PRINT "3.SPECMN HEIGHT (mm):"TAB(23)J$(6)TAB(37)"6.SPECIMEN
    DIA.(mm):"TAB(60)J$(7)
700 PRINT  \ TXTSPOS(,13,7) \ TXTUNLINE \ PRINT "TEST PARAMETERS" \ TXTNORMAL
710 PRINT TAB(6)"1.LOAD APPLIED(N):   ";GTAB(45)"4.LOAD WAVEFORM:       ";L$(7)
720 PRINT TAB(6)"2.FREQUENCY (Hz):    ";L$(2);",";L$(3);",";L$(4)TAB(45)"5.TEST
    TEMPERATURE(C): ";L$(6)
730 PRINT TAB(6)"3.LOADING TIME(s):   ";L$(5) \ PRINT  \ TXTSPOS(,18,7)
740 TXTUNLINE \ PRINT "TEST RESULTS" \ TXTNORMAL
745 TXTSPOS(,19,7) \ PRINT "DYNAMIC MODULUS, MPa:"
750 TXTSPOS(,19,30) \ TXTBOLD \ PRINT USING "-####.#^^^^^",E4; \ PRINT "@";F1;"Hz"
752 TXTSPOS(,20,30) \ PRINT USING "-####.#^^^^^",E5; \ PRINT "@";F2;"Hz"
754 TXTSPOS(,21,30) \ PRINT USING "-####.#^^^^^",E6; \ PRINT "@";F3;"Hz" \ TXTNORMAL
760 TXTSPOS(,23,7) \ PRINT "NOTES (<128 characters): ";
762 INPUT #0:R$ \ IF R$="" THEN GO TO 770
```

```
764 M4$=M4$+R$ \ IF LEN(M4$)>=127 THEN GO TO 770
766 GO TO 762
770 PRINT TAB(22)"<CR> TO GET MENU, ANY OTHER - TO QUIT: "; \ INPUT #0:R$
780 IF R$<>"" GO TO 1230
790 GO TO 1150
800 D9=1900+VAL(V1$) \ M9=VAL(V2$) \ Y9=VAL(V3$)
810 K1=INT(.6+(1/M9)) \ K2=D9-K1 \ K3=M9+12*K1 \ K4=K2/100 \ K5=INT(K4/4)
820 K6=INT(K4) \ K7=INT((5*K2)/4) \ K8=INT(13*(K3+1)/5)
830 K9=K5-K6+K7+K8+Y9-1 \ K9=K9-(7*INT(K9/7))+1 \ K2$=K3$(K9)&"DAY" \ RETURN
840 CLRTXWIN \ GOSUB 1920 \ REM Test Notes screen
845 GOSUB 895
850 FOR I=1 TO I1 \ TXTSPOS(,2+I,43) \ INPUT #0:J$(I) \ IF J$(I)=CHR$(63) THEN 1150
860 NEXT I
870 FOR I=1 TO I2 \ TXTSPOS(,12+I,47) \ INPUT #0:L$(I) \ IF L$(I)="?" THEN 1150
880 NEXT I
885 GO TO 960
887 CLRTXWIN \ GOSUB 1920
888 GOSUB 895
889 FOR I=1 TO I1 \ TXTSPOS(,2+I,43) \ PRINT J$(I) \ NEXT I
891 FOR I=1 TO I2 \ TXTSPOS(,12+I,47) \ PRINT L$(I) \ NEXT I
893 GO TO 960
895 VTMODE \ CLRTXWIN
900 PRINT CHR$(27)+'P1p'
905 PRINT "P(1,1)V(B)(+797)(,+477)(-797)(,-477)(E)"
910 PRINT CHR$(27)+'\';
915 TXTSPOS(,2,2) \ TXTUNLINE \ PRINT "SAMPLE AND TEST IDENTIFICATION" \TXTNORMAL
920 FOR I=1 TO I1 \ TXTSPOS(,2+I,3) \ PRINT "<"+STR$(I)+">"TAB(4)I$(I) \ NEXT I
925 TXTSPOS(,12,2) \ TXTUNLINE \ PRINT "TEST SPECIFICATIONS" \ TXTNORMAL
930 FOR I=1 TO I2 \ TXTSPOS(,12+I,2) \ PRINT "<"+STR$(12+I-2)+">"TAB(5)K$(I) \ NEXT I
935 TXTINVERS
940 FOR I=1 TO I1 \ TXTSPOS(,2+I,43) \ PRINT '          ' \ NEXT I
945 FOR I=1 TO I2 \ TXTSPOS(,12+I,47) \ PRINT '     '; \ NEXT I
950 PRINT CHR$(27)+"(4I" \ REM Replace mode, if not yet in
955 RETURN
960 REM Verify data input
965 PRINT CHR$(27)+'P1p' \ REM Small box
970 PRINT "P(525,340)V(B)(+265)(,+130)(-265)(,-130)(E)"
975 PRINT CHR$(27)+'\';
980 TXTNORMAL \ TXTBOLD \ TXTSPOS(,19,56) \ PRINT "Any changes?(Y/N): "; \
    INPUT #0:R$
985 IF R$<>'Y' THEN IF R$<>'N' THEN 980
990 IF R$='N' THEN 1030
995 TXTNORMAL \ TXTSPOS(,20,54) \ PRINT E0$+": ";
1000 TXTSPOS(,21,65) \ TXTINVERS \ PRINT '  ' \ TXTSPOS(,21,65) \ INPUT #0:I
```

```
1005 IF I<1 THEN 1000
1010 IF I>(I1+I2) THEN 1000
1015 IF I<=I1 THEN TXTSPOS(,2+I,43) \ INPUT #0:J$(I)
1020 IF I>I1 THEN TXTSPOS(,3+I,47) \ INPUT #0:L$(I-I1)
1025 GO TO 980
1030 TXTSPOS(,23,56) \ PRINT "Touch <CR> to proceed "; \ INPUT #0:B1$
1035 IF B1$<>"" GO TO 1030
1150 RESTORE  \ X0=0 \ READ N5 \ SETDIM C$(N5),O$(N5)
1160 FOR I=1 TO N5 \ READ C$(I),O$(I) \ NEXT I
1161 CLRTXWIN \ PRINT CHR$(27)+'P1p';'S(I0,E,C0)W(I2,N0,P1,M1,F3,V,S0)'
1162 IF Q0=99 THEN 1174
1167 PRINT "@:KP(+128)C(W(I2,S1))(+8)@;"
1168 PRINT "@:LP(,+72)C(W(I2,S1))(+8)@;"
1169 PRINT "@:MC(W(I2,S1))(+8)@K@K@K@K@K@K@;"
1170 PRINT "@:N@L@L@L@L@L@L@;"
1171 PRINT "P(15,12)V(W(S0))(B)(+769)(,+455)(-769)(,-455)(E)"
1172 PRINT "P(15,12)@MP(15,467)@MP(15,36)@NP(784,36)@N" \ Q0=99
1174 PRINT "P(30,25)V(W(S0))(B)(+737)(,+430)(-737)(,-430)(E)"
1176 PRINT CHR$(27)+'\'
1178 TXTSPOS(,4,T2) \ TXTINVERS \ PRINT T2$ \ TXTNORMAL
1180 TXTSPOS(,7,T3) \ TXTUNLINE \ PRINT T3$ \ TXTNORMAL
1185 PRINT CHR$(27)+"(4h" \ REM Uderline cursor
1190 FOR I=1 TO N5 \ TXTSPOS(,8+I,28) \ PRINT C$(I);" ";O$(I) \ NEXT I
1200 TXTSPOS(,19,29) \ PRINT "Your Choice (Enter #): "; \ INPUT #0:B1
1210 ON B1 GO TO 840,887,1300,1150,530,590,1700,1230
1220 TXTSPOS(,22,25) \ PRINT "THAT'S NOT AVAILABLE, TRY AGAIN" \ GO TO 1200
1230 CLRTXWIN \ PRINT  \ PRINT TAB(30)"ARE YOU SURE?(Y/N) "; \ INPUT #0:R$
1240 IF R$="N" THEN 1150
1250 IF R$<>"Y" THEN 1150
1260 CLRTXWIN \ GO TO 2000
1270 CLRTXWIN \ PRINT CHR$(27)+'P1p' \ PRINT "S(I0,E,C0)W(I2,N0,P1,M1,F3,V,S0)"
1280 PRINT "P(90,150)T(S2,H6)'DYNAMIC MODULUS TEST IN PROGRESS..." \ RETURN
1290 PRINT CHR$(27)+'\' \ RETURN
1300 M1=.01 \ M2=6.00000E-04 \ U1=VAL(L$(8)) \ U2=VAL(L$(9))
1310 H=VAL(L$(10)) \ F1=VAL(L$(2)) \ F2=VAL(L$(3)) \ F3=VAL(L$(4))
1320 L1=0 \ L2=-VAL(L$(1))/10 \ T0=VAL(L$(5))
1330 DIM A1(3,3) \ A1(1,0)=F1 \ A1(1,1)=2*F1*T0 \ A1(1,2)=L1 \ A1(1,3)=L2
1340 A1(2,0)=F2 \ A1(2,1)=2*F2*T0 \ A1(2,2)=A1(1,2) \ A1(2,3)=A1(1,3)
1350 A1(3,0)=F3 \ A1(3,1)=2*F3*T0 \ A1(3,2)=A1(1,2) \ A1(3,3)=A1(1,3)
1360 SETDIM VA2(2*T0*(F1+F2+F3),1),VA3(2*T0*(F1+F2+F3),1)
1370 SETDIM W(2*T0*(F1+F2+F3)),D(2*T0*(F1+F2+F3))
1380 ADPKVAL(1,VA2,,2,M1) \ ADPKVAL(2,VA3,,5,M2) \ CKTIME(1,1.00000E-03,C)
1390 FGIMMED(1,'R', TIME 1,0) \ FGREPT(1,'S', FREQ ,, ARRAY A1)
1400 CLRTXWIN \ TXTSPOS(,3,15) \ TXTINVERS
```

```
1410 PRINT "PLEASE VERIFY THAT THE CONTROLLERS' SETTINGS ARE CORRECT."
1420 TXTSPOS(,5,14)
1430 PRINT 'ZERO TRANSDUCERS. VERIFY YOU ARE IN DESIRED MODE OF CONTROL.'
1440 TXTNORMAL \ TXTSPOS(,7,17) \ TXTBOLD
1450 PRINT "  'ESC S' MAY BE USED TO STOP THE TEST AT ANY TIME." \ TXTNORMAL
1460 TXTSPOS(,11,27) \ PRINT "ENTER 'GO' TO BEGIN THE TEST: "; \ INPUT #0:R$
1470 IF R$<>'GO' THEN 1460
1480 GOSUB 1270
1490 ADINIT \ ADGO \ FGGO
1500 FGSTATUS(1,S) \ IF S<>0 THEN 1500
1510 ADSTOP \ FGSTOP \ FGIMMED(1,'R', TIME 1,0) \ GTIME(E7,E8,E9) \ CLRTXWIN \
     GOSUB 1290
1520 TXTSPOS(,5,33) \ TXTINVERS \ PRINT "TEST COMPLETED" \ TXTNORMAL
1530 TXTSPOS(,10,28) \ TXTFLASH \ PRINT "COMPUTING. PLEASE WAIT..." \ GO TO 1550
1540 FGSTOP \ ADSTOP \ FGIMMED(1,'R', TIME 2,0) \ GO TO 1150
1550 FOR I=1 TO 2*T0*(F1+F2+F3) \ W(I)=ELEVEL(VA2(I,1))*10 \ D(I)=ELEVEL(VA3(I,1))*10
     \ NEXT I
1560 I=2*(F1*T0-4) \ W1=0 \ D1=0
1570 FOR J=1 TO 3 \ W1=(W1+(W(I)-W(I+1)))/J \ D1=(D1+(D(I+2)-D(I+1)))/J \ I=I+2 \
     NEXT J
1580 I=2*(T0*(F1+F2)-4) \ W2=0 \ D2=0
1590 FOR J=1 TO 3 \ W2=(W2+(W(I)-W(I+1)))/J \ D2=(D2+(D(I+2)-D(I+1)))/J \ I=I+2 \
     NEXT J
1600 I=2*(T0*(F1+F2+F3)-4) \ W3=0 \ D3=0
1610 FOR J=1 TO 3 \ W3=(W3+(W(I)-W(I+1)))/J \ D3=(D3+(D(I+2)-D(I+1)))/J \ I=I+2 \
     NEXT J
1620 Z=VAL(J$(7)) \ A1=3.14159*Z^2/4 \ S1=W1*U1/(A1*10^6) \ S2=W2*U1/(A1*10^6) \
     S3=W3*U1/(A1*10^6)
1630 E1=D1*U2/H \ E2=(D2*U2)/H \ E3=(D3*U2)/H
1640 S0=(S1+S2+S3)/3 \ E0=(E1+E2+E3)/3
1645 E4=INT((10^6*S1/E1+.5)*10)/10 \ E5=INT((10^6*S2/E2+.5)*10)/10 \
     E6=INT((10^6*S3/E3+.5)*10)/10 \ REM Result in MPa
1650 E=INT((10^6*S0/E0+.5)*10)/10 \ GO TO 1150
1700 REM Test results - Saving Sub
1710 CLRTXWIN \ IF X0=.99 THEN PRINT TAB(21)"TEST RESULTS ARE SAVED ALREADY!" \
     INPUT #0:R$ \ GO TO 1150
1720 OPEN "TSTC" AS FILE #1
1730 FOR I=1 TO 7 \ INPUT #1:H2$(I) \ INPUT #1:H3(I)
1740 IF H2$(I)="DMT" THEN H3(I)=H3(I)+1 \ T5=H3(I) \ F2$=STR$(T5)
1750 NEXT I
1760 CLOSE #1
1770 OPEN "TSTC" FOR OUTPUT AS FILE #1, FILESIZE 1
1780 FOR I=1 TO 7 \ PRINT #1:H2$(I) \ PRINT #1:H3(I) \ NEXT I
1790 CLOSE #1
```

```
1800 F2$="DMT"+F2$+".MTS" \ OPEN F2$ FOR OUTPUT AS FILE #2, FILESIZE 5, ERROR X8
1810 M$(1)=SEG$(J$(5),1,2)+"("+SEG$(J$(5),3,6)+")" \ M$(2)=STR$(T5) \
     M$(3)=V2$&"/"&V1$&"/"&V3$
1820 M$(4)=SEG$(J$(2),1,1)+"."+SEG$(J$(2),2,2)+"."+SEG$(J$(2),3,5)+"."+SEG$(J$(2),6,7)+
     "."+SEG$(J$(2),8,10)
1825 M$(5)=SEG$(J$(3),1,2)+"/"+SEG$(J$(3),3,4)+"/"+SEG$(J$(3),5,6)
1830 M$(6)=SEG$(J$(4),1,1)+"-"+SEG$(J$(4),2,3)+"-"+SEG$(J$(4),4,6) \ M$(7)=J$(6) \
     M$(8)=J$(7)
1835 M$(9)=SEG$(J$(1),1,4)+"."+SEG$(J$(1),5,7)+"."+SEG$(J$(1),8,10)
1840 M$(10)=J$(8) \ M$(11)=J$(9) \ M$(12)=L$(8) \ M$(13)='0.0' \ M$(14)=L$(9) \
     M$(15)='0.0' \ M$(16)=L$(6)
1850 M$(17)=L$(11) \ M$(18)=L$(1) \ M$(19)=L$(2)+','+L$(3)+','+L$(4) \
     M$(20)=STR$(3*VAL(L$(5)))
1860 M$(21)=L$(10) \ M$(22)=STR$(E4) \ M$(23)=STR$(E5) \ M$(24)=STR$(E6) \
     M$(25)=SEG$(M4$,1,32)
1865 M$(26)=SEG$(M4$,33,64) \ M$(27)=SEG$(M4$,65,96) \ M$(28)=SEG$(M4$,97,127)
1870 FOR I=0 TO 28 \ PRINT #2,USING "<################################",
     M$(I) \ NEXT I \ REM 32-char string
1880 PRINT #2,"{(0)}" \ CLOSE #2
1885 REM IF X1=.88 THEN RETURN
1890 TXTSPOS(,10,18) \ TXTINVERS \ PRINT "TEST RESULTS SAVED IN FILE: ";F2$
1900 X0=.99 \ TXTNORMAL \ INPUT #0:R$
1910 GO TO 1150
1920 PRINT TAB(18)CHR$(27)&"#3";"DYNAMIC MODULUS TEST"
1925 PRINT TAB(18)CHR$(27)&"#4";"DYNAMIC MODULUS TEST"
1930 TXTSPOS(,4,60) \ PRINT "Date: "DAT$(D$) \ TXTSPOS(,5,60) \ GTIME(S9,M9,H9) \
     PRINT "Time: "H9;":";M9
1940 PRINT  \ TXTUNLINE \ PRINT "COMMENT:" \ TXTNORMAL
1950 PRINT "* "; \ INPUT #0:C0$
1960 IF C0$="" THEN PRINT "---------- end of user notes ----------
     ------" \ GO TO 1980
1970 GO TO 1950
1980 INPUT #0:C0$
1990 RETURN
2000 END
```

EXAMPLE OF INPUT TO THE PROGRAM and CORRESPONDING TEST RESULTS

USER'S INPUT TO THE PROGRAM

```
SAMPLE AND TEST IDENTIFICATION
 <1> PAVEMENT SAMPLE ID.(A999999X99):
 <2> SPECIMEN ID.(AAX99XA999):
 <3> DATE OF SAMPLE (MMDDYY):
 <4> MIX DESIGN ID.(AA9999):
 <5> TEST ID.(AA9999):
 <6> SPECIMEN HEIGHT (mm):
 <7> SPECIMEN DIA.(mm):
 <8> SPECIMEN MASS (kg):
 <9> DISTANCE FROM PAVEMENT EDGE (m):
TEST SPECIFICATIONS
<10> LOAD TO BE APPLIED (volts):
<11> LOADING FREQUENCY #1-highest (Hz):
<12>    "        "      #2-intermediate (Hz):
<13>    "        "      #3-lowest (Hz):
<14> TIME OF LOADING AT EACH FREQUENCY (s):
<15> TEST TEMPERATURE (C):
<16> LOAD WAVEFORM(S,R,SQ):
<17> LOAD CALIBRATION FACTOR (N/volts):
<18> STRAIN CALIBRATION FACTOR (mm/volts):
<19> SPACING BETWEEN LVDT CLAMPS (mm):
<20> TEST HUMIDITY (%):

Any changes?(Y/N): N

Touch <CR> to proceed
```

TEST RESULTS

The highest frequency

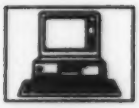
* TABLE OF LOAD-STRAIN DATA POINTS *

TIME (s)	LOAD -Peak- (Volts)	LOAD -Valley- (Volts)	STRAIN -Peak- (Volts)	STRAIN -Valley- (Volts)
11.375	-.493405	-4.60735	.0274792	.0167929
11.4375	-.490962	-4.60644	.0277846	.0167929
11.5	-.494932	-4.59972	.0280899	.0170982
11.5625	-.477833	-4.60857	.0274792	.0167929
11.625	-.490352	-4.6101	.0271739	.0170982
11.6875	-.489436	-4.60186	.0274792	.0167929
11.75	-.501649	-4.60155	.0277846	.0174035
11.8125	-.491573	-4.58873	.0271739	.0167929
11.875	-.491268	-4.60247	.0274792	.0167929
11.9375	-.479971	-4.60644	.0277846	.0167929
12	-.495237	-4.59453	.0277846	.0170982
12.0625	-.501343	-4.59361	.0280899	.0170982
12.125	-.48394	-4.60796	.0274792	.0167929
12.1875	-.487298	-4.60369	.0271739	.0167929
12.25	-.486993	-4.60399	.0277846	.0174035
12.3125	-.496458	-4.61315	.0280899	.0174035

The intermediate frequency

* TABLE OF LOAD-STRAIN DATA POINTS *

TIME (s)	LOAD -Peak- (Volts)	LOAD -Valley- (Volts)	STRAIN -Peak- (Volts)	STRAIN -Valley- (Volts)
52.25	-.25403	-4.53407	.0297005	.0174035
52.5	-.257694	-4.5353	.0290059	.0177088
52.75	-.255252	-4.52553	.0290059	.0174035
53	-.250061	-4.53407	.0290059	.0180142
53.25	-.249145	-4.52736	.0293112	.0180142
53.5	-.258305	-4.53621	.0299218	.0183195
53.75	-.247618	-4.53163	.0302272	.0186248
54	-.250366	-4.53743	.0296165	.0180142
54.25	-.250672	-4.53255	.0299218	.0192355
54.5	-.252809	-4.52919	.0299218	.0183195
54.75	-.256168	-4.54018	.0299218	.0186248
55	-.259831	-4.52491	.0299218	.0189301
55.25	-.249756	-4.52369	.0299218	.0186248
55.5	-.25403	-4.53041	.0305325	.0192355
55.75	-.254336	-4.52278	.0308378	.0192355



The lowest frequency

* TABLE OF LOAD-STRAIN DATA POINTS *

TIME (s)	LOAD -Peak- (Volts)	LOAD -Valley- (Volts)	STRAIN -Peak- (Volts)	STRAIN -Valley- (Volts)
90	-.153578	-4.53407	.0290059	.0155716
91	-.168845	-4.52949	.0302272	.0155716
92	-.15999	-4.52919	.0302272	.0167929
93	-.159585	-4.53133	.0299218	.0164875
94	-.158158	-4.53072	.0311431	.0174035
95	-.161212	-4.5298	.0305325	.0167929
96	-.166402	-4.53591	.0299218	.0170982
97	-.154494	-4.53652	.0308378	.0180142
98	-.160601	-4.53713	.0311431	.0170982
99	-.163043	-4.52858	.0311431	.0174035
100	-.162738	-4.54018	.0302272	.0167929
101	-.16457	-4.53713	.0302272	.0164875
102	-.159685	-4.53285	.0302272	.0174035

TEST REPORT

TEST REPORT

** DYNAMIC MODULUS TEST **

DATE OF TEST: 28-Apr-92
TUESDAY * 12 : 34 : 31
TEST ID.: DM0005

SAMPLE IDENTIFICATION

1.PAVEMENT SAMPLE ID.:	A100222607	4.DATE OF SAMPLE:	042892
2.SPECIMEN ID.:	LDA07AA222	5.MIX DESIGN ID.:	LH1000
3.SPECMN HEIGHT (mm):	203	6.SPECIMEN DIA.(mm):	101.6

TEST PARAMETERS

1.LOAD APPLIED(N):	1957	4.LOAD WAVEFORM:	S
2.FREQUENCY (Hz):	16,4,1	5.TEST TEMPERATURE(C):	-5
3.LOADING TIME(s):	40		

TEST RESULTS

DYNAMIC MODULUS. MPa: 2227.5 E+1 @ 16 Hz
2157.5 E+1 @ 4 Hz
1891.9 E+1 @ 1 Hz

NOTES (<128 characters): Test run smoothly. Everything was set properly.